PERGAMON

Renewable and Sustainable Energy Reviews
5 (2001) 191–200

RENEWABLE
& SUSTAINABLE
ENERGY REVIEWS

www.elsevier.com/locate/rser

The activities in wind energy in Hungary

Gabor Horvath *, Laszlo Toth

Department of Agroenergetics, Faculty of Mechanical Engineering, Saint Stephen University, Pater Karoly u.1, 2103 Godollo, Hungary

Received 2 August 2000; accepted 4 August 2000

Abstract

The main theme of this article is the economics of wind energy investment in Hungary. The first wind measurements evaluated in conformity with EU standards were made in the centre of Hungary. The first wind turbine installation was planned in the hilly region on the bank of the river Danube near Dunaujvaros. The local wind regime was described with on site measurements and calculations as the first step. The wind speed measurements were carried out from the beginning of 1999. The wind resource is favourable in this part of the country. The results and the feasibility study indicate that the wind power plant installation is feasible and would achieve financial payback of the investment in case of governmental support. Local tower production for local installation has also been investigated. © 2001 Elsevier Science Ltd. All rights reserved.

Contents

* Tel.: +36-209-914-330; fax: +36-28-420-997.
E-mail address: ghh@nexus.hu (G. Horvath).

PII: S1364-0321(00)00010-1

1. Introduction

Historically, Hungary has relied almost exclusively upon non-renewable fossil fuels as its primary energy supply. Hungary faces an era of increasing use of renewable energy sources in the coming century that will require the development of fundamental knowledge on wind energy to use this clean and affordable energy source efficiently.

Nowadays, the use of renewable energy is becoming an important objective. Wind energy is currently viewed as one of the most promising renewable energy sources. The use of wind energy has no toxic emissions so this matter will be important with regard to EU energy aims. Wind energy is the fastest growing renewable energy source in the world. It is not an easy task to choose a site for a wind turbine because many factors have to be taken into account. The most important factors are wind speed, the energy of the wind, the generator type and the feasibility study.

2. The project of wind resource mapping in Hungary

Although wind energy is widely used in the EU member countries, it is almost unknown in Central and Eastern Europe. Only a small number of wind turbines have been installed in the Czech Republic, a few in Poland, while no modern wind turbines exist so far in other countries.

There are three main obstacles to wind energy in these countries:

1. No real effort had been made to determine the optimal locations for exploitation of wind energy; there is no Wind Atlas for Hungary. Meteorological data are measured at the locations suitable for other “classical” purposes, while no systematic measurements or modelling has been done for potential locations with high wind energy.
2. The economics for installation of wind power plants cannot be compared to the EU standard, therefore only a few excellent sites may be valuable at first—another reason for good site evaluation. With a further increase in the price paid per kWh, more sites will become exploitable.
3. A wide-ranging lack of credibility in the possibilities of wind energy exists in Hungary.

As a consequence, the objectives of the project are to set up a demonstration procedure for a Central European country to establish a modern wind-turbine power

plant; from evaluation of possible wind potentials and site determination to the real exploitation. Hungary, where the project is proposed to be carried out, is a country where the Alpine and Panonia Flat climate types meet, so the determination of possible wind potentials (Wind Atlas) and their characteristics would be useful to a number of surrounding Central European countries.

Existing wind data examination, wind modelling and dedicated wind monitoring has been carried out, and economic, urban and legal issues has been examined and summarized in a guide for the installation of a wind turbine at one location. Finally, this site has been examined at the economic level to demonstrate the possibilities for installation of a wind energy converter.

3. Plans

There are plans for local production of towers and blades but there was no great desire from any wind turbine company to work out this idea. It is known that European wind turbine manufacturing companies are engaged with larger orders. To date, in order of appearance, the following companies have been interested in installation: Bonus, Enercon, Vestas, NEG-Micon and Tacke. It is hoped that after the installation of the first wind turbine, interest will increase and an attempt will be made to manufacture in some parts in Hungary.

4. The law for energy from renewables

In Hungary, there is a law (1994, XLVIII/43 and 1996/55) for every licensed electricity company for purchasing renewable power. The company may not refuse to take the energy if it complies with the technical requirements. The cost of this source of energy is 10–15% higher than the cost of electricity made by fossil-fuelled power plants or a nuclear power plant. The price for renewable power is set ar roughly 0.05 EURO/kWh. A totally free market—where all methods of making electricity compete on the same level—exists in Hungary.

Nuclear power currently supplies about 50% of Hungary's electricity needs. However, the costs and long-term hazards associated with the decommissioning of nuclear plants and the handling of radioactive waste are well known.

The Hungarian government has not taken any steps towards the formal adoption of strategy and programmes on increased use of energy from renewable sources. There is an action plan to be followed for each renewable source in order to reduce carbon dioxide emissions, but so far there has been no real action.

The government has pledged to cut carbon dioxide emissions by 6% (4.8 million tonnes) of 1987 levels and to meet 6% of our electricity needs from renewable sources from today's 3% by the year of 2010. The time scale for implementation of these changes is unclear. In my opinion, renewable energy and, in particular, wind energy would play a major role in achieving these targets. The Ministry of Economic

Affairs claims that the most significant increase will come from biomass, geothermal and solar energy and does not yet believe in wind power.

- There is a plan to increase the rape-oil production regardless of local unfavourable circumstances. Mainly eastern tractors are used in agriculture, but they would need to be rebuilt for this purpose. The agropotential is only 200 000 ha of land in this country for this purpose and the demand from the food industry ensures that the rape yield is bought up immediately.
- The water level fell 15–25 m through progressive use of geothermal energy in the Great Plane region under communism.
- The plan to install 20 000 solar cells in Hungary would yield an amount of energy in ambient sun and wind conditions equivalent to five medium-sized (600 kW) wind turbines.
- A good example of using wind energy is the working wind farms 5–10 km from the Austrian–Hungarian border.

The electricity companies in Hungary are mainly German-owned. Renewable energy would cost more, so their decision on supporting wind energy will influence the future of renewable energy use in Hungary.

5. Research

The Department of Agroenergetics of Saint Stephen University has been carrying out research for several years on the use of wind energy and measuring wind energy potential in Hungary. There is no installed wind turbine in Hungary as yet. There is an opportunity for installation in a place 60 km south of Budapest on the bank of the River Danube in cooperation with the First Hungarian Wind Turbine Trading and Supplying Company Ltd. Saint Stephen University monitored wind speed and direction over a 1-year period. On the basis of these measurements we can say that the yearly wind speed average is greater than 5.5 m/s at a height of 35 m, which is feasible for wind turbine operation in EU countries. The planned machine is a 600-kW wind turbine. A typical, well-sited, 600-kW turbine has an average output sufficient to meet the electricity needs of over 500 homes. This clean output results in a reduction in the amount of fossil fuels which have to be burnt, such that it offsets the emission of around 1500 tonnes of carbon dioxide (the main greenhouse gas) and 20 tonnes of acid rain gases every year.

The official papers for installation permission are held by the aforementioned company. There are no other significant obstacles to this project. The company owns 50% of the total financial investment. It has price offers from more WEC companies but no final decision has yet been taken. If successfully realized, the measured results would be confirmed with real energy production.

There is another project proposed to put together the Hungarian Wind Atlas (see Fig. 1) by the university, the company and the Hungarian Meteorological Institute. To achieve this, we would participate in the EU Fifth Framework Program. Under

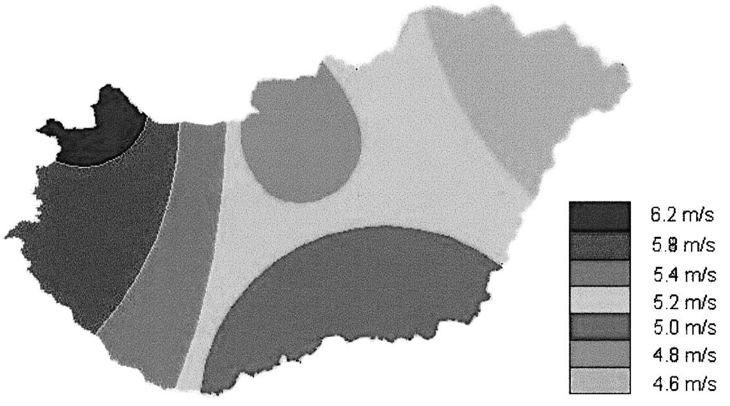

Fig. 1. The expected wind speeds at 50 m in the Hungarian Wind Atlas.

EU rules Hungary is not able to put forward this proposal alone so there is a need for a joint EU partner. An institution or consulting company from another EU member country would have to submit the EU proposal. The university is looking for prospective partners.

5.1. Wind measurement

The first wind turbine installation was planned at Kulcs, 60 km south of Budapest (Fig. 2). The wind speed measurements were carried out from the beginning of 1999. Topographical and wind speed measurement data were collected as a first step. The wind speed and wind direction were measured at two different heights (see

Fig. 2. The place of measurement in the centre of Hungary.

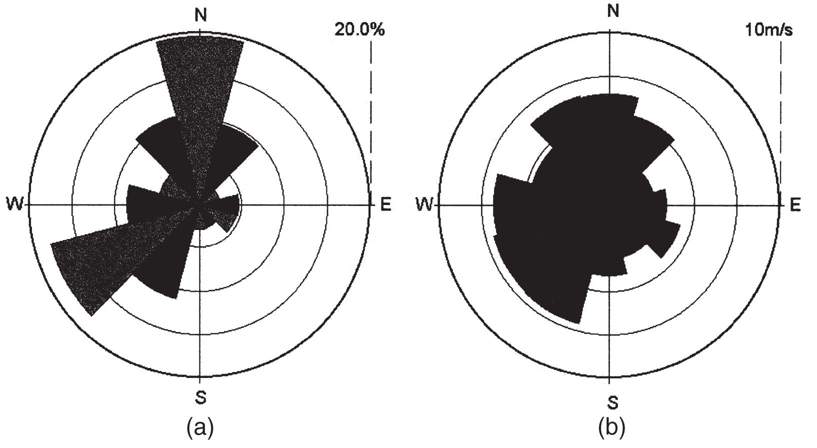

Fig. 3. A wind rose from the Kulcs site: (a) the main wind directions; (b) the mean wind speeds.

Figs. 3–5). The measurement device was an Ammonit Windsiter 420. The data obtained from these measurements indicate that the economic nacelle height is above 60 m. There was a limited area for wind turbine installation. There are other land uses on this hill, called Oreg Debella. For example, there are peach farms, a health clinic and a state prison.

5.2. Feasibility study

We planned (Table 1) the investment on 25 years of expected lifetime (Fig. 6), the nominal power of the generator is 600 kW and the total investment is 615 385 EURO (Fig. 7).

Distribution of investment cost (%):

- wind generator (generator, turbine blades etc.) 70%

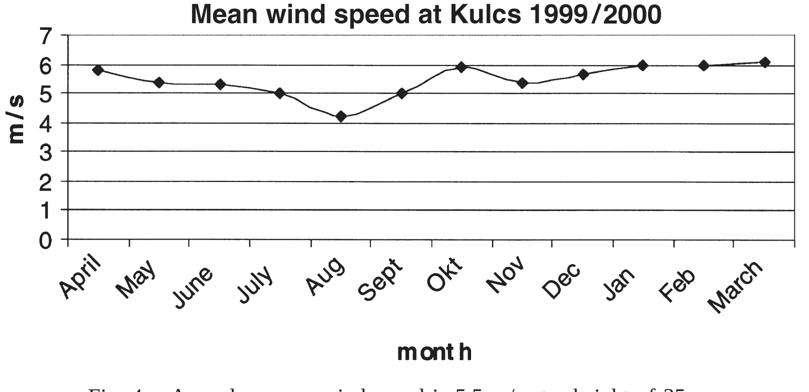

Fig. 4. Annual average wind speed is 5.5 m/s at a height of 35 m.

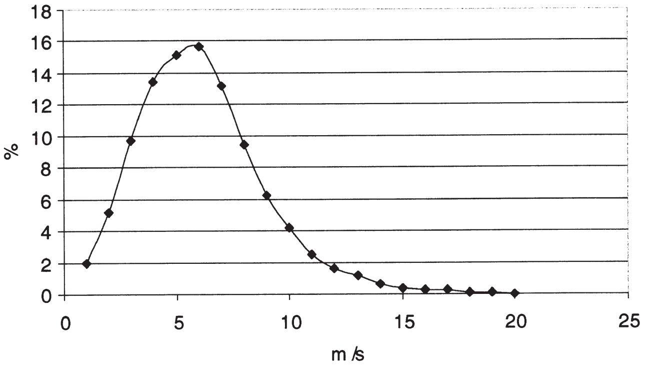

Fig. 5. Annual wind speed distribution from May 1999 to April 2000, at 35 m, Kulcs, Hungary.

- feasibility study, design, authorization 3%
- foundation, transformer, steel tower 7%

The estimated annual wind energy production is 1600 MWh at Kulcs. The design lifetime of a wind turbine is between 20 and 30 years in Western Europe. We assumed 25 years of lifetime. The average price paid for the EU's renewable energy is about twice that of Hungary. Our calculations were made on the basis of a large increase in the Hungarian energy price. The price of electricity in Hungary will probably catch up with the average EU price by 2005, although this is not at all certain.

The Wind Company has three different financial sources of capital investment:

- credit from founders
- support without payback
- credit with a low rate of interest

The main investment figures are:

- construction period <1 year
- real interest 5%
- simple payback (SPB) 11 years
- net present value (NPV) 1 198 930 EURO
- internal rate of return (IRR) 14%

The calculated economic indicators are:

- simple payback (SPB)
- net present value (NPV)
- internal rate of returns (IRR)

The investment is attractive if:

Table 1
The calculated wind turbine investment cash flow table for 25 years

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1. Income	18577	71077	85681	98629	110497	121606	131358	141858	153194	160929	175426
2. Operation and maintenance cost	7692.3	8076.9	8461.5	8846.2	9230.8	9615.4	10000	10385	10769	11154	11538
3. Investment	615385	0	0	0	0	0	0	0	0	0	0
4. Credit payback	0	0	30769	30769	34615	42308	46154	0	0	0	0
5. Interest payment	7461.5	20308	19846	16154	12615	8461.5	4123.1	0	0	0	0
6. Depreciation	0	12308	12308	12308	12308	12308	12308	12308	12308	12308	12308
7. Taxable value (1–2)	10885	63000	77219	89788	101267	111991	121358	131474	142425	149775	16388
8. Tax avoidance (5+6)	7461.5	32615	32154	28462	24923	20769	16431	12308	12308	12308	12308
9. Tax ((7–8)*18)	616.15	5469.2	8111.8	11038	13742	16420	18887	21450	23421	24744	27284
10. Profit after taxes (7–9)	10268	57531	69107	78745	87525	95571	102471	110024	119004	125031	136603
11. Cash flow (7-9-3-4)	-605116	57531	38338	47976	52909	53263	56318	110024	119004	125031	136603
12. Net present value of the cash flow	-605116	54791	34774	41443	43529	41733	42025	78192	80546	80596	83863
13. Accumulated NPV of the cash flow	-605116	-550325	-515551	-474108	-430579	-3888846	-346821	-268629	-188083	-107486	-23624

2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
185988	197147	208976	221514	234805	246594	258924	271870	285464	299737	311789	32460	337230.9	350720
11923	12308	12692	13077	13462	13846	14231	14615	15000	15385	15769	16153.8	16538.46	16923.1
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
12308	12308	12308	12308	12308	12308	12308	12308	12308	12308	12308	12307.7	12307.69	12307.7
174065	184839	196284	208438	221344	232748	244693	257255	270464	284352	296020	308107	320692.4	33797
12308	12308	12308	12308	12308	12308	12308	12308	12308	12308	12308	12307.7	12307.69	12307.7
29116	31056	33116	35308	37626	39679	41829	44090	46468	48968	51068	53243.8	55509.25	57868.1
144948	153784	163168	173134	183717	193069	202864	213164	223996	235384	244952	254863	265183.2	275929
144948	153784	163168	173134	183717	193069	202864	213164	223996	235384	244952	254863	265183.2	275929
84748	85633	86531	87445	88371	88447	88509	88574	88643	88714	87923	87124.8	885336.03	85556.7
61125	146757	233289	327033	409104	497551	586060	674634	763277	851991	939914	1027039	1113375	1198932

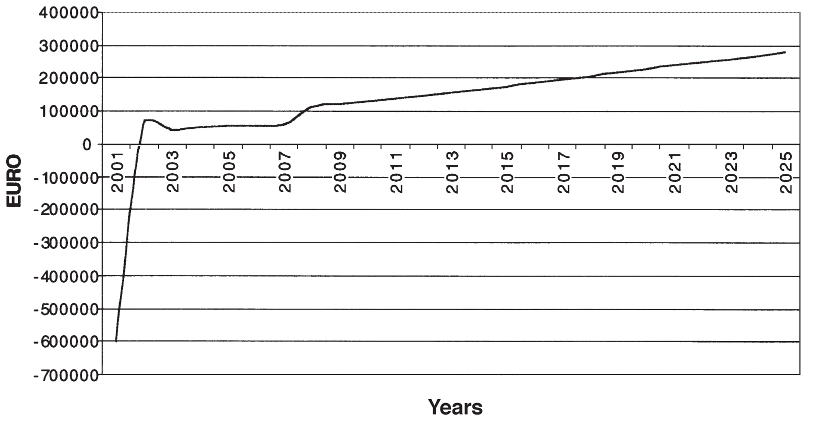

Fig. 6. The cashflow diagram.

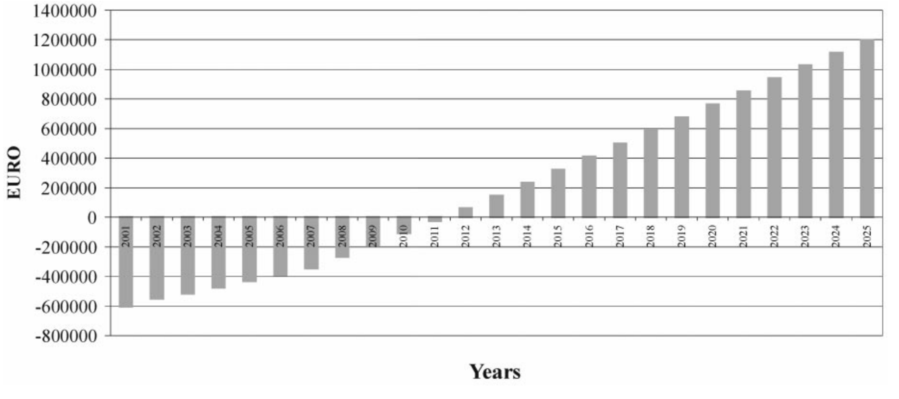

Fig. 7. The simple payback.

- the net present value of the project is more than zero;
- the internal rate of return is more than the real interest;
- the simple payback is short.

6. Conclusions

Special attention should be paid to the choice of site for a wind turbine. The theory of wind measurement is closely related to this subject. The first on-site wind measurement has been done in connection with a feasibility study. The installation needs a thorough planning procedure. The results showed that the project is feasible in the long term. The aim is to manufacture some parts in Hungary. There are factor-

ies for high-quality, steel-tower production and by manufacturing wind turbine blades locally, employment could be created in the area.

The decision about the above-mentioned project would be taken upon winning a proposal for:

- support without payback (Hungarian environmental support);
- credit with low rate of interest 8.5% (German coal aid).

The proposals are under judgement in The Ministry of Economic Affairs for two months. So the future of this project lies in their hands.

The main problems in the use of renewables in this country are:

- the agreement in Kyoto (on CO_2 reduction) did not inspire the Government because afterwards there was a great decrease in industrial production so the CO_2 emission decreased without increasing the use of renewables;
- the actual trend of exploitation of renewable energies is decided by politicians, and there is a large gap between the ideas of politicians and academics;
- people at the universities (like me) did not convince the public to choose leaders who will financially support the use of renewables in practice.

However, it is hoped that the first wind turbine in Hungary will be constructed by autumn this year.